Successful Sound Reinforcement in Arena Opera - A Case Study

Sound reinforcement in Arena Opera has long been a favourite subject of criticism, phrases such as distorted and disembodied voices or over-miked are commonly used. The February 2003 production of Madam Butterfly staged by Raymond Gubbay at the Royal Albert Hall however had several critics actually praising the sound. Unheard of!

There is no doubt that sound reinforcement is as important as any of the other skills that are employed to make a large scale production work. In the case of Madam Butterfly, an 'In the Round' production translated into English, most of the time the performers are singing with their backs to half of the audience so sound reinforcement has a particularly important role to play.

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Good sound reinforcement or at least the mark of a job well done, is that no one either noticed it or the lack of it, while poor sound reinforcement can do much to undermine a production and an audiences' involvement. Loudspeakers barking at them from the wrong direction distract from the stage action and undermine the magical state of willing suspension of disbelief.

Effective sound reinforcement is necessary for the audience to hear and understand the words and so follow the plot, and this is especially important for works sung in the listener's native language. Intelligibility is partly reliant on loudness and audio fidelity, that is to say, the quality of equipment from microphone to loudspeaker and the skill of the sound engineer mixing the show. It is also heavily dependent on avoiding echoes and excessive reverberation.

Perhaps of greatest importance to an audience's immersion and involvement, however, is *audio localisation*, to assist their effortless perception of who is speaking or singing.

Our ears often guide our eyes but if sound reinforcement presents a unidirectional wall of sound, then the ability of our ears to do the guiding is impaired. The audience is forced into what was recently described by LA Times opera critic Michael Phillips as playing "voice detective", trying to work out who is singing.

In arena opera, successful sound reinforcement must be able to deliver clear, unobtrusive and, above all, *intelligible* sound. Loudspeakers should point at the audience from about the same direction as the stage, and must be fairly close to the audience to reduce the amount of excitation of the space, thereby minimising echoes and reverberation. The final requirement is that the sound reinforcement must be directional and accurately represent the location and the movement of the actors and singers being reinforced.

Fortunately, a trick of the ear can be exploited to make sound directional and appear to come from an actor or singer even though it is also coming from a loudspeaker, possibly much louder and closer and from another direction.

The trick is called Precedence and describes our ears' sensitivity to the arrival direction of the *first* sound wave-front. In addition, the ear has a remarkable ability to ignore very short subsequent echoes, and this can be exploited in a sound reinforcement scenario to render the amplified sound from loudspeakers effectively "inaudible"..

Exploitation of this trick involves care in placement of the loudspeakers and dynamic management of time delays from each actor's microphone to each loudspeaker's coverage area, in sympathy with the relative positions of one to the other.

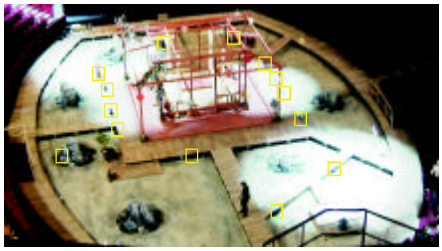
The amplified sound of each voice must get to the audiences' ears within 20mS (20 thousandths of a second) or less *after* the un-amplified sound direct from the mouth of the performer - this is equivalent to the time taken for sound to travel 7 meters.

The following case study describes an 'In the Round' production of Madam Butterfly staged in February 2003 at the Royal Albert Hall, London, where these so called 'Source Oriented Reinforcement' ('SOR') techniques were used.

Staging, rigging, set and loudspeaker placement

For the best results, stage and set design must allow for suitable loudspeaker placement from the outset. The broad requirement is for every seat in the house to be in the coverage area of a loudspeaker pointing at them from the general direction of the stage.

Main reinforcement loudspeakers should ideally be closer to the audience than the action, and it may be necessary to build additional imaging speakers into the set.



Stage Loudspeaker Positions

The Butterfly set allowed for a total of 14 stage loudspeakers to be mounted both on rock islands and under the raised platform of the house and the various walkways. The speakers were far enough into the stage so as to have line of sight to the front rows of audience and in all but a few places were in ideal positions.

A further 32 overhead loudspeaker groups were hung on the two flown rectangular lighting trusses. Speakers on the inner truss covered the stalls and boxes while the speakers on the outer truss covered the upper circle.

Loudspeakers dressed as rocks

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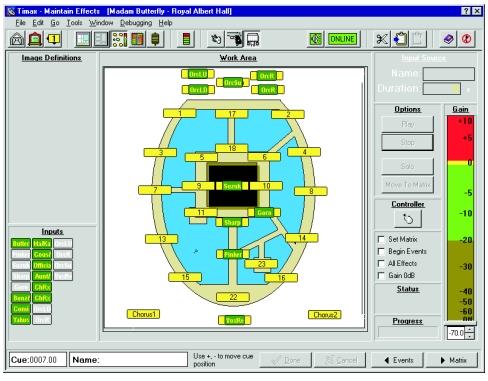
As is often the case, audience sightlines dictated that this grid had to be flown quite high, a factor which made it even more important to employ SOR audio imaging techniques so as to avoid an unnatural and disembodied "sound heaven" outcome.

Time delay management

Sound travels quite slowly, so as a performer moves around the stage the relative timing between their direct voice and their amplified voice changes; in the case of the Butterfly stage by as much as 80mS. For a performance 'In the Round' the relationship is unique for every seat. With knowledge of the spatial distance relationships between the stage, speakers and seats, time delays can be appropriately manipulated to maintain timing precedence for the voice and minimise echoes from the amplification system to below our hearing's threshold of echo perception - around 20mS.

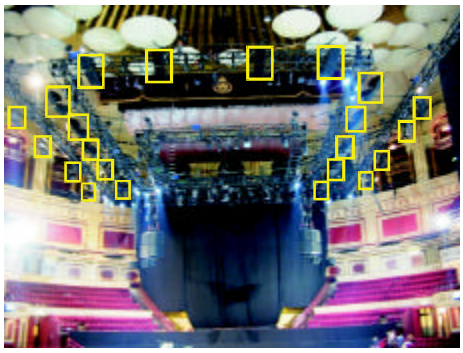
In practice, successful Source Oriented Reinforcement involves teaching a computer the movements of the performers on the stage then measuring and inputting the spatial distance data, so the computer can calculate and apply the correct time delays from each microphone to each loudspeaker. It does this by a series of Cue-driven instructions a digital audio time delay matrix system in the case of Madame Butterfly, the Out Board TiMax ™ system.

By plotting the movements of actors during rehearsals, the sound engineer can later step through a set of pre-programmed Cues in the computer to make the audio delay matrix move their audio images around the stage to follow the action during the show. This results in a sound reinforcement outcome that is sympathetic to the performance as opposed to a more conventional "wall-of-sound" which can distract rather than complement the overall purist objectives of the production.



TiMax control software

Each Principal is equipped with a radio microphone mounted about their person. All the signals are balanced at the mixing console and routed to separate inputs on the time delay matrix. The time delay matrix processes each microphones' signal applied to each loudspeaker so the precedent acoustic wavefronts coming from every performer reaches each audience member before any amplified wavefronts. In Butterfly, 27 separate loudspeaker systems were used for vocal sound reinforcement and 4 orchestra reinforcement.



Flown Loudspeaker placement

Other Raymond Gubbay arena opera productions featuring TiMax SOR over recent years include Tosca, Aida, Carmen, Pagliarchi y Caviellera Rusticana and two other landmark productions of Madam Butterfly. This latest 2003 Madam Butterfly season attracted positive comments about sound quality from mainstream classical opera commentators, as did the run of "Pag & Cav" shows in late 2002. The hitherto controversial medium known to the cognoscenti as 'enhanced opera' seems to have come of age, made possible by SOR audio imaging techniques and TiMax technology.

Factors that contributed positively to a successful outcome

Good stage lip loudspeaker positioning so most of the seats were in the coverage of a loudspeaker pointing at them with a minimum angle of deviation from the main focal area of the stage.

Stage lip speakers disguised as rocks on islands in the set provided for ideal placement, around 2 meters from the perimeter of the stage and up just high enough to have line of sight to the front rows of seats and those beyond.

Flown speakers covering the upper circle were fairly close to their audience and so could be accurately targeted. This helped to control echoes bouncing across the auditorium from speakers on the opposite side being reflected by the large curved hard surface of the front of the balcony.

A greater number of more accurately defined localisation zones representing action areas of 4 meters diameter.

Precise laser measurement of distances from stage localisation zones to speaker zones.

Good annunciation by the cast; it has often been commented that if performers are under less pressure to project because they are amplified, they find it easier to articulate clearly. Amplifying a mouthful of vowels only really sounds like a louder mouthful of vowels and can be almost completely incomprehensible. The flip side of this is that if performers do not project at all then higher gain amplification is required. This brings with it higher noise levels from extraneous microphone pickup and lessened ability of the audiences to localise the perceived source of the voice to the performer.

What would have made further improvements

Improved coverage from the stage lip for audience areas either side of the orchestra where ideal placements were not possible within the constraints of the set design. In these areas the sound of the orchestra is considerably louder than anywhere else so the voices need extra sound reinforcement support.

Loudspeakers covering the stalls could have been lower while not blocking sight lines. At a distance of some 14 meters from seats in the 5th row and a performer only 5 meters away, the amplified sound from the speaker will arrive in time later than the threshold of echo perception.

Automated tracking of the performers on the stage would reduce system setup time considerably as well as improving timing accuracy between the amplified and acoustic sound.

The Author:

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www.outboard.co.uk